March 21, 1899.

W. T. Blanford, Esq., LL.D., F.R.S., Vice-President, in the Chair.

Mr. E. T. Newton, F.R.S., exhibited some specimens of his *Mus abbotti* and made the following remarks:—"Among the fossil remains of small rodents found in the ossiferous fissure at Ightham, Kent, and described in 1894 (Quart. Journ. Geol. Soc. vol. 50. p. 188), were a few rami of mice resembling those of *Mus sylvaticus*, but wanting the characteristic front tubercle of the anterior lower cheek-tooth. This fossil form was named *M. abbotti*, after Mr. Lewis Abbott, whose zeal in working out the fissure had brought to light these and many other interesting fossil remains. Mr. Barrett-Hamilton has called my attention to the fact that Mr. Waterhouse had previously used the name of *Mus abbotti* for a mouse from Trebizond (Proc. Zool. Soc. 1880, p. 61). I regret my oversight, and avail myself of the opportunity, so courteously afforded me, of rectifying the error. It is proposed to name the fossil mouse *Mus lewisi*, so that it may still be associated with its energetic discoverer."

A communication was read from Dr. G. Stewardson Brady, C.M.Z.S., containing an account of the Copepoda collected, chiefly by means of the surface-net, by Mr. G. M. Thomson, of Dunedin, and by Mr. H. Suter, on behalf of the Zoological Museum of Copenhagen. It was shown that several species were identical with well-known European forms, and others closely allied, but that many were entirely distinct and presented very interesting peculiarities.

This paper will be published in full in the Society's 'Transactions.'

The following papers were read:—

1. Contributions to the Osteology of Birds. Part III. *Tubinares*. By W. P. Pycraft, A.L.S.

[Received February 7, 1899.]

(Plates XXII. & XXIII.)

Contents.

i. Introductory Remarks.

Not a little has already been written on the Osteology of the

Tubinares in the very valuable memoirs of Milne-Edwards (14), Brandt (3), Huxley (12), Forbes (5–6), Gadow (8–9), Lydekker (13), and others. Nevertheless, in working carefully through the collection of skeletons of this group in the British Museum, I found that much yet remained to be done, in the way of bringing these facts together, so that, carefully sorted, they might be brought yet more fully to bear upon the question of the systematic position of the group. In this I think I have had a fair measure of success. Besides also I have been enabled to add, here and there, a few original observations.

Following the plan of my last paper, I propose first of all to deal with (ii.) the Adult Skull, then with that of (iii.) the Nestling, following this with (iv., v.) the Axial Skeleton, (vi.) the Sternum and Pectoral Girdle, (vii.) the Pelvic Girdle, (viii.) the Pectoral Limb, and (ix.) the Pelvic Limb.

ii. The Skull of the Adult.

The skull of the Petrels, like that of the Impennes and Colymbi, is schizognathous, holorhinal, and marked by deep supraorbital grooves; but it can at once be distinguished therefrom by its large, laterally expanded vomer fused posteriorly with the palatines, an olfactory cavity of great size—except in *Pelecanoides* and *Puffinus assimilis*,—and the markedly hooked upper jaw. The mandible retains a distinct dentary suture and coronoid, the free end of which last terminates in a more or less heart-shaped expansion. The angulare is truncated, and the internal angular process is small.

The Occipital Region.—The dorsal border of the supra-occipital region in the Procellariidæ is strongly arched; in the Diomedeidæ the curve of this border is very slight. The curve is produced downwards on either side into the paroccipital processes, which project, or rather depend, from the skull in the form of conical "bosses." The aperture of the foramen magnum varies in form and size. The occipital condyle is sessile, save in *Diomedea exulans*, in which it is produced backwards on a stout base so as to project considerably behind the foramen. In certain genera—e. g., *Thalassœca*, *Daption*, *Œstrelata*, *Prion*, *Priocella*, some species of *Puffinus*, *Oceanites*, *Cymodroma*, *Pelagodroma*, and *Procellaria*—the supra-occipital presents the concavo-convex form so characteristic of the *Sphenisci*. In other forms this swelling is hardly perceptible.

The Roof of the Cranium.—The fronto-parietal region is more or less furrowed in the median line, thus indicating the position of the pallial cerebral fissure; similarly, in many cases—*Thalassœca*, *Priofinus*, *Œstrelata*, *Puffinus*—the cerebellar prominence is transversely ridged, the ridges corresponding to the underlying sulci of the cerebellum. The temporal fossæ vary much in the extent of their development. In *Priofinus*, *Fulmarus*, *Majaqueus*, *Ossifraga*, and many species of *Œstrelata* and *Puffinus* they rise dorsally so as to be divided only by a narrow median

sagittal crest; in others this crest is very broad. In *Procellaria*, *Pelagodroma*, *Oceanites*, and *Cymodroma* these fossæ can hardly be said to exist.

The interorbital region of the frontals is, like the region posteriorly, gently furrowed and moderately wide. This feature, however, does not obtain throughout the group, but varies according to the form and depth of the supra-orbital grooves on either side. Thus in *Procellaria* the interorbital region is very broad, relatively broader than in any other Petrel. In this case the supra-orbital grooves look outwards and not upwards as usual, being only narrow and shallow depressions scooped out of the free edge of the frontal. In *Cymodroma* these grooves are very short antero-posteriorly, their length being less than the width across the frontals between the lachrymals. This occurs in no other Petrel. In *Oceanites* and *Pelagodroma* the grooves of either side are practically confluent, reducing the interorbital region to a faint and barely perceptible ridge. The grooves are wider posteriorly than in any other forms, crossing the skull almost transversely in this region. In *Pelecanoides*, *Priocella*, and *Phœbetria* the grooves are divided by a high, narrow ridge, which in *Priofinus* becomes wide enough to permit the existence of the median groove previously referred to, whilst in *Pelecanoides* it has acquired a knife-like edge. In none of the Procellariidæ is there ever any pronounced supra-orbital ledge such as obtains in the Penguins. In some, as in *Priocella*, this is feebly developed, but it is never conspicuous. In the Diomedeidæ the case is otherwise. In this group, and especially in *Diomedea exulans*, it may be as well developed as in *Catarrhactes* amongst the Penguins, and, as in this genus and that of *Pygoscelis*, the free edge of this ledge is greatly flattened.

The Base of the Skull.—The typical Procellarian form of the basitemporal plate of the parasphenoid is triangular, with a free anterior border. From this it follows that the Eustachian passages are represented by grooves intead of tubes. In *Procellaria*, *Oceanites*, *Cymodroma*, *Pelagodroma*, *Bulweria* (occasionally), *Puffinus* (*P. kuhli*), and *Pelecanoides* a tube is more or less perfectly formed, by the downgrowth of a thin plate of bone from the alisphenoidal wings of the parasphenoid. In all the Procellariidæ except *Pelecanoides* there is a more or less conspicuous aperture, receiving numerous pneumatic foramina, opening downwards immediately above the pneumatic grooves, to the inner side and a little in front of the articular surface of the quadrate. This aperture is in some cases of very considerable size, e. g. *Fulmarus glacialis*: a probe passed down it, in a forward direction, leads into the parasphenoidal rostrum. In the Diomedeidæ this aperture is smaller and opens directly backwards rather than downwards; furthermore, it is situated much nearer the middle line than in the Procellariidæ, inasmuch as it does not pass the level of a line drawn through the mammillary processes, whilst in the latter, as just stated, it opens near the quadrate articular surface. In

Diomedea exulans, in addition to the aperture just described, there is a second, opening immediately into the Eustachian groove. This takes the form of a deep cleft lying on either side of the rostrum. In other species of this genus and in *Thalassogeron* and *Phœbetria* the Eustachian groove is shallower and wider, and does not receive pneumatic apertures.

The *basitemporal plate* of *Pelecanoides* differs markedly from that of all the rest of the group, in that it extends the whole width of the base of the skull lying between the quadrates. In all the other Petrels the angles of the triangular base are widely distant from the quadrate on either side. Pneumatic apertures such as those just described are wanting.

Mammillary processes occur only in *Ossifraga* amongst the Procellariidæ and in the Diomedeidæ. In other members of the group the place which these occupy is indicated by a slight protuberance which is continued inwards to meet its fellow of the opposite side in the form of a low ridge. In *Diomedea*, *Thalassogeron*, and *Ossifraga* is a well-marked tubercle lying between the mammillary processes. This is absent in *Phœbetria*. A deep hollow—the paroccipital notch—divides the mammillary from the paroccipital processes, which are moderately well developed, pneumatic, and with a sharp free edge. In the smaller Petrels, e. g. *Oceanites*, *Pelagodroma*, the outline of the basitemporal plate is continued directly backwards into these processes, there is no hollowing out at its base as in the larger species. A precondylar fossa is present in all, but is especially well-marked in the larger forms.

The *parasphenoidal rostrum* is of uniform calibre throughout and terminates anteriorly in the form of a spine extending up to, or beyond, the level of the mesethmoid. It may or may not support basipterygoid processes. These are largest in *Ossifraga*. In *Fulmarus*, *Priocella*, *Daption*, *Pelecanoides*, and *Œstrelata* they are still very distinct. In *Puffinus* they vary in size, from distinct processes to mere vestiges. In *Procellaria* and *Cymodroma* they are represented by minute prickles. In *Pelagodroma* and *Oceanites* and the Diomedeidæ they are wanting entirely.

The Lateral Aspect of the Cranium.—The tympanic cavity is in the dried skull represented by a small, shallow cavity bounded in front by the pneumatic aperture opening near the quadrate articular surface, above by the overhanging articular surface for the otic head of the quadrate, behind by the paroccipital process, and below by the mammillary process (when this is present). The *fenestra ovale* and the *fenestra rotunda* pierce the wall of this cavity, opening immediately within its mouth; behind and above these apertures is the mouth of a large pneumatic cavity leading upwards between the supra-occipital and the proötic bones.

The *temporalis recess* is a large tubular cavity opening forwards above the articulation of the quadrate; it runs upwards under the temporal fossa to terminate near the middle line, in the region of the lambdoidal ridge. This recess is very small in *Daption*,

Bulweria, *Pelecanoides*, and the small Petrels, e. g. *Oceanites*, *Procellaria*, *Cymodroma*.

The *squamosal prominence* (see p. 394) forms the roof and external boundary of the mouth of the temporalis recess, and affords an articular surface for the squamosal head of the quadrate. The paroccipital process (p. 394) is largest in the larger forms; its outer free border runs upwards and forwards to join the squamosal prominence, forming therewith a sharply truncated outstanding process of the skull. Its inner free border can be more or less easily traced running inwards and somewhat forward to the base of the mammillary process of the region representing this.

The *temporal fossæ*.—In all the Procellariidæ the temporal fossæ, when present, take the form of conical depressions, more or less deep, rising obliquely upwards and backwards from the postorbital and squamosal region, which may be taken to form the base of the cone to the sagittal crest in the mid-dorsal line. By means of this fossa the outline of the cerebral and cerebellar regions of the brain are plainly indicated. This is particularly well marked in the case of *Priofinus*, and scarcely less so in that of some species of *Œstrelata* and *Puffinus*. Thus, this region of the skull comes to bear a close resemblance to that of the Penguins. It differs therefrom, however, in the more oblique position of the fossa and the more backward position of the squamoso-parietal wings.

In the Diomedeidæ the temporal fossæ differ conspicuously from those of the Procellariidæ, for, instead of taking the form of more or less deep grooves tending to cut off the cerebral from the cerebellar portions of the skull, they are represented only by shallow depressions, of uniform depth, on either side of the parietal region of the skull, and are only discernible by reason of the low ridge representing the periphery of the attachment of the tempo ralis muscle.

The *trigeminal foramen* lies in a more or less deep fossa into which opens the mouth of the temporalis recess: it is situated immediately above the mouth of the large pneumatic aperture already described in the Procellariidæ as lying dorsad of the Eustachian grooves. In *Diomedea exulans* there is a second smaller foramen immediately below the trigeminal, but this is a pneumatic orifice.

The *orbits* in the Procellariidæ are only very imperfectly roofed in above. The postorbital process serves to protect the eye from above and behind and the lachrymal in front; the outer border of the nasal gland protects it above. The interorbital septum forming the mesial wall, dividing the two cavities, is perforated. It is bounded antero-internally by the antorbital plate, and postero-internally by the orbito- and alisphenoids. The orbitosphenoid is only very incompletely ossified; thus in the dried skull the orbit is placed in communication with the brain-cavity. In *Cymodroma*, *Oceanites*, *Bulweria*, and *Pelecanoides* the interorbital septum is practically wanting, being represented only by a slender bar of

bone from the dorsal region of the rim of the optic foramen forwards to the interorbital plate.

The *orbitosphenoid* in the Diomedeidæ is completely ossified; the roof of the orbit is more or less perfectly protected by a supra-orbital ledge, such as occurs in the Penguins.

The optic foramina in Diomedeidæ, *Ossifraga*, *Fulmarus*, *Priocella*, *Prion*, *Daption*, *Thalassœca*, and some species of *Puffinus* and *Œstrelata*, are divided by a median septum one from another; in the rest the septum is absent and the two apertures are confluent.

The *ethmoidal region*.—The *mesethmoid* is indistinguishably fused below with the parasphenoidal rostrum, from which it rises as a thin vertical plate of bone, in the median line. Its dorsal border is expanded so as to underlie the nasal and frontal bones, extending outwards on either side to the level of the free edge of the supraorbital groove. The anterior border of the mesethmoid is of considerable width; postero-dorsally it extends backwards to play the part of a crista-galli dividing the *olfactory fossæ* into right and left lateral chambers; its postero-ventral border is merged with the interorbital septum when present. The aliethmoid is only the ectoethmoidal ossification and forms the antorbital plate. This, in the Procellariidæ, is generally of very considerable size. In *Bulweria* it takes the form of an almost vertical plate of bone, projecting nearly at right angles from the posterior border of the mesethmoid, and running outwards to the lachrymal. Its dorsal border becomes continuous with the free edge of the expanded mesethmoid. Its postero-dorsal angle is more or less hollowed out and trends downwards to join the median horizontal bar of bone representing the interorbital septum. This antorbital plate serves to enclose two spacious olfactory chambers divided one from another by the mesethmoid. Anteriorly they are in direct communication with the lachrymo-nasal fossa, posteriorly with the brain-cavity. *Procellaria*, *Oceanites*, and *Cymodroma* more or less resemble *Bulweria* in this respect. In *Fulmarus*, *Thalassœca*, *Œstrelata*, *Daption*, and *Prion* the form of the antorbital plate resembles that just described. In these genera, however, the outer border is fused with the lachrymal. In all the genera so far enumerated the dorsal border of the lachymal is pierced by two foramina. Of these, one lies immediately under the free edge of the frontal, and the other between the lachrymal and the aliethmoidal wall. In *Priocella* these two foramina are merged into one, forming a deep emargination between the dorsal wall of the antorbital plate and the frontal; externally this plate and the lachrymal are fused as in *Fulmarus*, &c. The outer of these two foramina—the lachrymal—in *Priofinus*, *Majaqueus*, and *Puffinus* is of great size; in all except a few species of *Puffinus* the antorbital plate remains distinct from the lachrymal.

In the Diomedeidæ the antorbital plates are represented by a pair of narrow lateral wings, which never extend dorsally to meet the frontal. In *Phœbetria* they extend laterally so as to pass behind, and project slightly beyond, the level of the lachrymal.

The antorbital plate of *Pelecanoides* resembles that of the Diomedeidæ, but is narrower and does not quite reach to the level of the lachrymal.

The *olfactory cavity* is of great size in all the Tubinares except *Pelecanoides* and *Puffinus assimilis*; in these it is reduced to a chamber of comparatively insignificant size.

The *lachrymal* is of very considerable size and more or less T-shaped. It extends from the fronto-nasal region downwards to the quadrato-jugal bar. The stem, anteriorly, is provided with a large lachrymal foramen. In *Œstrelata* and *Thalassœca* the posterior limb is laterally expanded and rises upwards, its free edge looking outwards and backwards. In *Priofinus* this peculiarity is repeated, but in a less marked degree. *Ossifraga*, *Procellaria*, *Oceanites*, *Cymodroma*, *Pelagodroma*, and *Bulweria* all agree in having the anterior limb produced far forwards, so much so that the horizontal exceeds that of the vertical axis, the former being represented by a line traversing the arms, the latter the stem. In *Cymodroma*, *Oceanites*, and *Pelagodroma* there is a wide chink separating the dorsal border of the anterior limb from the fronto-nasal border.

In *Pelecanoides* the anterior and posterior limbs are almost obsolete, the anterior limb is pierced by a large foramen, and the inner, nasal border is notched. The vacuity in the stem of *Puffinus assimilis* is very large.

In the Diomedeidæ the anterior and posterior limbs, as in *Pelecanoides*, are freely developed. In *Diomedea melanophorus* the anterior is wanting. In *Phœbetria* the posterior limb is produced outwards, backwards, and upwards more than in any other member of the order.

The lachrymal is ankylosed with the nasal in *Ossifraga*, *Fulmarus*, *Daption*, *Prion*, *Thalassœca*, *Œstrelata*, and *Priocella*.

The *ossiculum lachrymo-palatinum*, or "os crochu," is best developed in the Diomedeidæ. In *Diomedea exulans* it is a styliform bone, the upper half of which is of a more or less triangular spatulate form; the lower is cylindrical. Seen *in situ*, from in front, the inner border is concave, the outer triangular. It articulates above with a process from the inner border of the lachrymal, by means of its laterally compressed dorsal extremity, and below by a ligament to the outer border of the palatine. In *Thalassœca*, *Prion*, *Bulweria*, and *Priofinus* it is represented by a small slender rod, which in the first-mentioned is almost hair-like in thickness. In both it depends from the distal end of the lachrymal below its junction with the antorbital plate, and extends downwards towards the palatine, with which, doubtless, in life it is connected by ligament. In all the other specimens under my charge it is wanting. The late W. A. Forbes (6) gives a brief survey of this bonelet and its relations to the various surrounding parts. In many cases it is represented only by a vestigial nodule imbedded in ligament. It occurs also, according to Forbes, in the "Musophagidæ, many Cuculidæ, *Chunga*, and *Cariama*, as well as

in some Laridæ and Alcidæ, so that its presence is obviously of no particular taxonomic value." Brandt (3) and Rheinhardt (17) have made numerous and careful observations concerning this bone.

The Cranial Cavity.—The *metencephalic fossa* takes the form of a moderately deep basin with gently sloping sides. It is steepest in front, where it rises to terminate at the dorsum sellæ. In the posterior region, just behind and below the internal auditory meatus, lies the large vagus foramen, and further back, near the outer border of the occipital condyle, is the condyloid foramen. In the anterior region, near what one might call the "rim" of this basin, on a level with the floor of the *pituitary fossa* and to its outer side, lies the *abducent foramen*.

The *cerebellar fossa* is bounded by the supraoccipital behind, the parietal above, and the proötics below. In the Procellariidæ the parietal portion is deeply corrugated, the ridges running transversely. These represent the sulci, and the corresponding depression the positions of the gyri. This feature is less marked in the Diomedeidæ; moreover, in the latter this fossa can be more or less distinctly divided into a median and two lateral regions, the latter lying above and in front of the proötics.

The *mesencephalic fossa* lies in the alisphenoid and is moderately deep; its superior external boundary is formed by the tentorial ridge; its ventri-lateral border is pierced in the Procellariidæ by the trigeminal foramen and the foramen for a branch of the *vena cephalica posterior*. The former is the lower and opens externally just inside the ventral border of the mouth of the temporalis recess: the latter lies immediately above this and opens inside this recess. In the Diomedeidæ these two foramina may have a common aperture which lies in a depression below that of, and leading into, the temporalis recess.

The *pituitary fossa* is very deep and slopes obliquely backwards. The *dorsum sellæ* overhangs it posteriorly, whilst the *perpituitary ridge* bounds it in front; this last is more or less flattened so as to form an optic platform—representing the inferior border of the *optic foramen*. Similarly, the upper boundary of the optic platform is formed by a pre-optic ridge, which passes on either side into the tentorial ridge.

The *optic foramen* appears as a single aperture in many Procellariidæ; in the rest, and in the Diomedeidæ, it is more or less completely divided into a right and left aperture by means of the interorbital septum.

The *cerebral fossæ* lie entirely in front of the cerebellar fossa, from which they are separated by a well-defined tentorial ridge. This may be traced from the pre-optic platform outwards, backwards, and upwards to a point in the middle line, immediately above the centre of the floor of the metencephalic fossa, where it joins that of the other side. From the point of this junction there runs forwards, in the median line, a prominent ridge, the bony falx, which is continued forwards to the crista-galli, and marks the

division of the hemispheres dorsally. The cerebral fossa is of much greater relative size in the Diomedeidæ.

The *olfactory fossæ* are paired tubular cavities lying immediately in front of the cerebral fossæ, and leading out into the olfactory chamber by a wide aperture.

The Premaxilla.

The *premaxilla*—and, as will be shown presently, the whole facial skeleton—closely resembles that of the Ciconiiformes.

In the Tubinares it is in all cases more or less produced forwards and strongly hooked at the tip. In breadth it varies. In the Procellariidæ, amongst the smaller forms, e. g. *Oceanites*, what is probably the more primitive form of this region of the skull obtains, in that we can distinguish the three radiating prongs by which the premaxilla is bound to the rest of the jaw, viz., the median, paired, nasal processes and the lateral maxillary processes. In *Oceanites*, *Cymodroma*, &c. these are long and narrow and wide apart. Thus we get a long, median palatal vacuity, and elongated, paired, but horizontal and pervious nares. The nasal processes fuse proximately with the nasal bones and are never more than indistinctly to be made out in this region. The outer border of the maxillary processes in the larger Procellariidæ, e. g., *Fulmarus*, *Priofinus*—aided by the maxilla—take the form of vertically flattened plates, which in *Prion* become laterally expanded so as to make the beak boat-shaped—as in *Balæniceps* and *Cancroma* amongst the Ciconiiformes. The great development of these vertical plates causes the narial apertures to look upwards, rather than outwards as is usual. Moreover, it gives the jaw the appearance of great solidity, which attains its climax in the Diomedeidæ.

In all belonging to this subfamily—save the genus *Puffinus*—as already indicated, there is a large vacuity immediately distad of the maxillo-palatine processes and extending forwards to the tip of the jaw. In the genus just referred to as the exception to this rule, the vacuity is represented by a wide chink, not extending forwards further than the middle of the jaw, where the edges of the crevice meet to form a bony roof to this region of the mouth. There is an approach to this condition in *Priofinus* and *Majaqueus*. The palatal surface of the maxillary processes attains its maximum breadth in *Prion* and *Pelecanoides*. In the Diomedeidæ this premaxillary vacuity is reduced to a long narrow chink extending about as far as the middle of the jaw, when, as in *Puffinus*, the edges meet to form a bony palatal roof.

The Maxillo-jugal Arch.

As in the Ciconiiformes, the *maxilla*, in the adult, is indistinguishably fused with the premaxilla. The maxillo-palatine processes, in *Oceanites*, *Cymodroma*, and *Procellaria*, are represented by delicate horizontal, more or less fenestrated, leaf-shaped expansions approaching one another in the middle line. In the rest of the

Procellariidæ they are unfenestrated, and somewhat resemble those of the Laridæ in that they take the form of flattened lamellæ. They differ at once from the Gulls, however, in that they are never markedly concavo-convex, and never extend backwards into the lachrymo-nasal fossa. Furthermore, they differ in that they are hollowed out to form the large *antrum of Highmore*, which is provided with both anterior and posterior apertures. On the palatal surface they may appear, as in the Gulls, in the middle line, between the palatines, as short, somewhat scroll-like processes; whilst in others, e. g. *Priofinus*, they are quite concealed by the palatines.

In the Diomedeidæ the *maxillo-palatines* and the *antrum* attain a considerable size. The inner wall is an unfenestrated, vertical, concavo-convex lamella, projecting far back into the lachrymo-nasal fossa. It extends from the level of the posterior narial aperture downwards so as to depend in the median line, considerably below the level of the tomium—as in the Storks; then turns outwards and upwards to the tomium to contribute towards the formation of the palatal roof. In this ventral portion is embedded the distal end of the palatine. The *antrum* contains a little cancellated tissue. It opens posteriorly by three apertures—a median and inner, and two lateral; the former, in *Diomedea exulans*, extends the whole height of the *antrum*. In *Phœbetria* the corresponding aperture is very small. The share contributed by the maxilla to the quadrato-jugal arch cannot be very well made out in the adult, owing to the completeness of the fusion of the different elements.

The anterior end of the quadrato-jugal arch, in *Oceanites*, *Cymodroma*, *Procellaria*, *Pelagodroma*, *Bulweria*, and *Ossifraga*, by a slightly upward direction more or less reduces the size of the lachrymo-nasal fossa, giving it the form, in *Oceanites* for instance, of a wide chink. In all but *Pelecanoides* the lachrymal articulates with the quadrato-jugal bar. In *Ossifraga* this is brought about by means of a triangular bony process arising from the distal end of the jugal.

The Vomer, Palatine, and Pterygoid.

The *vomer*, like that of the Ciconiiformes and Anseriformes, is ankylosed with the palatines. In *Oceanites*, *Cymodroma*, *Pelagodroma*, and *Procellaria* it resembles that of *Phaeton* (a Steganopode), in that it is cleft in the middle line from behind forwards for the greater part of its length, the two resultant laminæ being turned slightly outwards. Thus, from below, the vomer appears as a tongue-shaped ossification, cleft for about half its length, from behind forwards, and terminating in a more or less decurved point. In *Pelecanoides* it is somewhat constricted caudad. In the remaining genera of the subfamily Procellariidæ the vomer is very broad and hastate in form, the sides are raised dorsally, and in *Majaqueus*, *Fulmarus*, *Thalassœca*, *Priocella*, and *Ossifraga* there is a more or less well-marked median dorsal ridge. The tip is more or less pointed and decurved. In *Ossifraga* the vomer, seen from

below, presents an elongated tumid swelling immediately behind the maxillo-palatine process; immediately in front of this it rises suddenly dorsalwards, and curving forwards above the maxillo-palatine descends to the level of the palatines, between their extreme anterior ends, in the form of a long spine-like process. A median keel traverses the ventral surface from the region of the tumid swelling forwards.

The vomer of the Diomedeidæ is peculiar in that, though dorso-ventrally depressed, its edges are not upturned; in that, about the middle of its length, it turns abruptly downwards, and then, at its tip, forwards. Furthermore, the ventral surface bears a deep median keel (Pl. XXIII. fig. 7). Seen from below, with the surrounding parts *in situ*, the vomer is discovered as a thin blade—the ventral keel—lying at the bottom of a deep, narrow cleft, formed by the palatines and maxillo-palatine processes. Immediately anterior to these last lies a short rod—the tip of the vomer (Pl. XXIII. fig. 8). The posterior dorsal surface of the vomer underlies the anterior end of the parasphenoidal rostrum. The junction of the vomer with the palatines is indicated by a notch on its posterior dorsal border.

The *palatine* in its general form, and in the nature of its junction with the vomer, agrees very closely with that of the Storks and Herons. Seen ventrally, and traced from before backwards, the anterior end is strap-shaped and underlies the maxillo-palatine process; more or less distant from the posterior free border of this, its inner border develops a strong keel, whilst the corresponding region of the outer border produces a similar, but smaller keel. Both terminate a short distance in front of the pterygoid articulation, the palatine in this region becoming suddenly rod-shaped. Dorsally, traced from the pterygoid forward, the palatine is more or less laterally compressed into a blade-like ridge, which, nearing the vomer, gives off from its outer border a thin, concavo-convex scroll of bone which runs gracefully forwards to terminate immediately behind the posterior maxillo-palatine border: meanwhile the main body of the palatine runs forwards to become almost, if not quite, indistinguishably fused with the vomer. The scroll-like plate just mentioned, seen laterally, often forms a high vertical crest—e. g., *Puffinus, Diomedea.*

In *Bulweria* the inner ventral keel is feebly developed, and the outer border rises upwards, scroll-wise, giving the whole palatine a tumid inflated appearance. In *Oceanites* and its near allies the ventral ridges of the palatine are but feebly developed. In *Ossifraga* the inner keel of the ventral surface is triangular. The palatine is pneumatic, the foramina opening at the foot of the dorsal crest.

The *pterygoid* in *Procellaria*, *Cymodroma*, *Oceanites*, and *Pelagodroma* is rod-shaped, without basipterygoidal facets or pneumatic apertures. *Pelecanoides* and *Bulweria* have also non-pneumatic pterygoids. The pterygoid of the remainder of the Procellariidæ is more or less rod-shaped and carved into a strong dorsal crest.

In *Prion* there is a tendency towards a distal expansion of the pterygoid, so marked a feature in the Sphenisci. Ill-defined basi-pterygoidal facets can be traced on the inner border just behind the point where the shaft rests upon the parasphenoidal rostrum; just within the inner border of the quadrate articular end is a small pneumatic foramen.

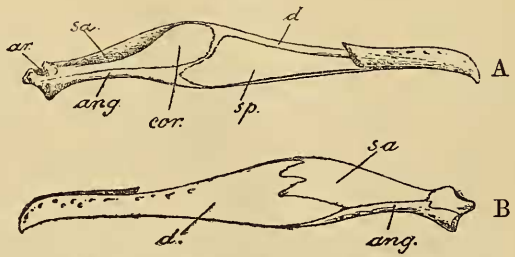
In the Diomedeidæ the pterygoids are relatively longer than in the Procellariidæ, they bear no trace of basipterygoidal facets, are quite rod-shaped, and rest upon the parasphenoidal rostrum only by the inner border of their extreme distal ends. The posterior pneumatic foramen is very large. In *Thalassogeron* the extreme distal end rises, upwards, above the pterygoidal articulation to embrace the rostrum. In *Diomedea exulans* only does there seem to be a total absence of a dorsal crest.

The *quadrate* differs from that of the Storks mainly in the disposition of the mandibular articular surfaces, in the absence of a pneumatic foramen between the posterior surfaces of the otic and squamosal articular surfaces, and the less marked division between the dorsal aspects of these two processes. The dorsal border is slightly hollowed; the orbital process large and expanded. The mandibular articular surface is very broad, runs at right angles to the long axis of the skull, and projects inwards considerably beyond the base of the orbital process. There is a very distinct head for articulation with the pterygoid. The outer mandibular condyle is marked by a strong median transverse depression, slopes obliquely backwards, and is separated by a wide groove from the inner, which takes the form of two grooves divided by a median ridge. The quadrato-jugal glenoid cavity lies in the outstanding process at the base of the outer side of the otic process.

The Mandible.

As in the Penguins, Storks, and Herons, the dentary suture and the spatulate free end of the coronoid (fig. 1) remain distinct through-

Fig. 1.



Inner (A) and outer (B) views of the lower jaw of a nestling *Oceanodroma leucorrhoa*.

ang., angulare; *ar.*, articulare; *d.*, dentary; *cor.*, coronoid; *s.a.*, supra-angular *sp.*, splenial.

out life. There is a more or less well-marked vacuity over the lower limb of the dentary suture which is closed by the coronoid. In the Procellariidæ there is a more or less well-marked pneumatic foramen opening into the dorsal surface of the internal angular process. In the Diomedeidæ there is a more or less well-marked posterior lateral vacuity which pierces the posterior end of the supra-angular. In *D. exulans*, immediately behind this vacuity, on the inner side of the jaw, is a large pneumatic foramen leading backwards below the glenoid surfaces. Furthermore, in this species there is a deep pit, receiving numerous pneumatic foramina, lying immediately behind the articular surface for the inner condyle of the quadrate. The angular is sharply truncated and the internal angular process is very small.

The Hyoid.

The *hyoid* most nearly resembles that of the Penguins and Storks, particularly the former. There is no osseous basihyal. In one skeleton of *Pelagodroma marina* in the Museum Collection I found a pair of ossified ceratohyals; these were probably also present in many other skeletons, but have been lost in maceration; the basibranchial, seen dorsally, is fan-shaped and more or less conspicuously hollowed. It is produced backwards into a short bony style, from the base of which spring the ceratobranchials. A similar, conical, bony style runs from the anterior border of the fan forwards and at right angles to its long axis. The ceratobranchials are rather more than twice as long as the epibranchials, which are tipped with cartilage.

iii. The Skull of the Nestling.

The sutures of the skull, unlike those of the Struthious birds and the Penguins, close early. But in very young nestlings the separate bones can all be traced. The skulls from which the following descriptions are taken are those of very young nestlings of *Oceanodroma leucorrhoa*.

The Cartilage-bones.

The cartilage-bones are now, for the most part, more or less completely ossified.

The *basioccipital* widens gradually from behind forwards. It is under-floored in front by the basitemporal plate, and bounded on either side by the exoccipitals, from which it is separated by a narrow synchondrosis; behind, it is rounded off to form the median portion of the occipital condyle.

The *exoccipital*.—The upper half of the posterior border of the exoccipital skirts the epiotic; the lower is excavated to form the lateral region of the foramen magnum. The share which it takes in the formation of the occipital condyle is a very small one. Its inner border is yet separated from the basioccipital by a

narrow synchondrosis widening slightly forwards. Its dorsal border is embedded in a mass of cartilage lodging the proötic, and dividing the exoccipital from the squamosal. Its anterior border looks somewhat upwards and outwards, and is continued dorsalwards into the proötic cartilage, whose free edge forms the posterior wall of the tympanic recess. Seen from within, the exoccipital is more or less flabellate anteriorly, with an elongate posterior stem. The inner segment of its convex border abuts against the basioccipital, the outer is bounded by the opisthotic. The stem is bounded on one side by the vagus foramen, on the other by the foramen magnum.

The *supraoccipital* is completely ossified inferiorly and separated from the exoccipital by synchondrosis. Its superior border is as yet very incomplete, deeply concave, with a crenated free edge. Thus a large lambdoidal or parieto-occipital fontanelle is formed. Its dorso-lateral angle joins the parietal, its ventri-lateral the exoccipital, by means of a short, narrow bar; between these two areas is a wide chink, separating the supraoccipital from the epiotic. The groove lying below this chink is scooped out of the thin plate of bone joining the epiotic to the supraoccipital.

The *epiotic*, seen from without, is represented by a subcrescentic tract of bone, bounded along its inner border, above by a wide chink, and below by the upper part of a deep groove from the supraoccipital. The upper end of its outer border is embedded in the proötic cartilage, its lower end is separated by a thin band of cartilage from the exoccipital. Seen from within, it takes the form of a perfectly free semicircular coil bounding the floccular fossa posteriorly. Its upper and lower ends are separated by cartilage from the proötic. It is fused with the supraoccipital by means of a narrow plate of bone extending from the posterior border of its inferior end. (Pl. XXIII. figs. 1, 2.)

The *proötic*, from the outside, appears as a broad oblong tract of cartilage lying between the squamosal and exoccipital. Its free border forms the posterior wall of the tympanic recess, and is continuous with that of the squamosal prominence. It is bounded posteriorly by the epiotic. The floccular fossa, at this stage, lies in this tract of cartilage, in the angle between the squamosal and parietal above, and the exoccipital and epiotic below.

On the inside, it is bounded by the epiotic behind, and the opisthotic below. Between its junction with the epiotic and the opisthotic its border is deeply excavated to form the outer boundary of the floccular fossa. Its supero-lateral border rests upon the lower end of the squamosal, and cuts off this bone from participating in the formation of the brain-case. It is bounded on either side by the parietal (behind) and the alisphenoid (in front); its anterior border is bounded in part by the alisphenoid, and in part by a mass of cartilage lying between this and the basisphenoid, which probably represents tissue into which ossification was destined to spread from the alisphenoid, proötic, and basisphenoid. The

trigeminal foramen lies above the internal and auditory meatus, between the proötic and alisphenoid.

The *opisthotic*, seen from without, is largely cartilaginous. Ossification has, however, begun in the shape of a crescentic nodule of bone lying immediately below the *fenestra ovalis* and above the *vagus foramen*.

Inside it serves to divide the exoccipital and proötic. Ossification has begun from two centres—caudad behind the *vagus foramen*, laterad of the extreme upper end of the exoccipital and at the base of the epiotic; and anteriorly, as a small nodule in the region corresponding with a line continuing the exoccipital suture outwards to the postero-ventral border of the proötic. Both ossifications have fused with the proötic, but remain separate from the exoccipital.

The *basisphenoid* is not visible from without, being concealed by the basitemporal plate. Inside it is bounded, caudad by the basioccipital, laterad by a tract of cartilage which divides it from the alisphenoid, and in the middle line, in front, by the cartilaginous presphenoid. It forms, with the basioccipital, the anterior region of the metencephalic fossa. The pituitary fossa is lodged in its anterior border, and is yet only a shallow depression with an aperture in its posterior border for the internal carotid canal. A mass of diploë divides the basisphenoid from the parasphenoid below.

The *alisphenoid* is more or less quadrate in form—viewed from without. Its outer border is convex and received into the concave border of the squamosal (Pl. XXIII. fig. 1). It is bounded above by the orbital plate of the frontal, below by the lateral wing of the parasphenoid (p. 384) and the trigeminal foramen.

The *orbitosphenoid* is represented only by a sheet of membrane.

The *presphenoid* is still cartilaginous and continuous in front with the mesethmoid.

The *mesethmoid* is a vertical linguiform plate resting upon the distal end of the parasphenoid below and underlying the nasals above. Its posterior border is semicircular, its anterior slopes obliquely backwards and terminates at the free end of the nasal process of the premaxilla.

The olfactory cavity, seen from the inside, after the removal of the mesethmoid, contains a large posterior and an elongated ventral accessory turbinal.

The *quadrate* does not differ materially from that of the adult. The otic and squamosal processes are somewhat less distinctly marked.

The *columella* has well-marked extra- and infrastapedial rays; the suprastapedium is very short.

The *articulare* can still just be distinguished as a separate element (fig. 1, p. 392).

The Membrane-bones.

The *parietal* is trapezoid. Its outer, anterior, and mesial

borders are straight, its posterior border is V-shaped. It does not extend forward beyond the level of the anterior $\frac{1}{3}$ of the vertically elongated squamosal. Its outer posterior border runs from the angle of the lower $\frac{1}{3}$ of the squamosal (Pl. XXIII. fig. 1) inwards to the upper half of the lateral border of the supra-occipital; its inner posterior border is in part approximated to but not yet fused with the supraoccipital, and in part free, bounding, with its fellow of the opposite side, the parieto-occipital fontanelle, as the supraoccipital bounds it ventrally.

The *frontal* is broadest posteriorly. Its mesial and posterior borders are straight. The latter, skirting the parietal posteriorly, sweeps forwards to the inner side of the squamosal, to articulate with the alisphenoid (Pl. XXIII. fig. 1). The free outer border is grooved for the supraorbital gland. The region above the alisphenoid constitutes the orbital plate of the frontal and is of small extent.

The *squamosal* is crescentic in form, the concave border forwards. The tip of the upper limb is free and bounds the supra-orbital groove posteriorly, furnishing the squamosal spines, so conspicuous in the species from which this description is taken, *Pelecanoides* and *Cymodroma*. The lower limb furnishes the squamosal prominence. It is almost entirely excluded from the inner wall of the skull.

The *nasal* is of great size, and conspicuously convex dorsally. It forms the outer roof of the large olfactory cavity. Beneath it lies the horizontal plate of the mesethmoid. Its posterior end is embraced on either side by the frontal. It is deeply notched forwards to form the anterior and external nasal processes. These constitute the posterior boundary of the narial aperture, which is holorhinal.

The *lachrymal* does not differ from that of the adult, p. 387.

The *premaxilla* has fused completely with the maxilla, even in the youngest of the two skulls. The nasal process yet, however, remains distinct.

The *jugal* and *quadrato-jugal* can only be imperfectly distinguished one from another and from the *maxilla*, which differs in no important particular from that of the adult.

The relations between the vomer, palatines, and pterygoid recall those between these elements in *Rhea* (Pl. XXIII. figs. 3, 4).

The *vomer* consists of a pair of elongated, flattened laminæ united in the median line anteriorly. The free posterior ends are received by the concave anterior borders of the hemipterygoids, and are bounded, on either side, by an inwardly turned scroll of bone from the dorsal border of the palatine.

The *palatine* is still free, its anterior end is traceable nearly as far forwards as the tip of the jaw. Posteriorly it develops a strong dorsal keel which eventually turns inwards and forwards to embrace the posterior lateral border of the vomer.

The *pterygoid* is rod-shaped, and continued forwards to articulate with the vomer by means of a large *hemipterygoid*

(Pl. XXIII. figs. 3, 4). This last differs from that of the Impennes, which I described recently (16), in that it is almost quadrate instead of triangular. It is notched at each end. The outer limb of the anterior notch fits into yet another notch formed between the inturned dorsal crest of the palatine and the outer border of the posterior end of the vomer. The posterior notch forms an articular surface for the pterygoid. The palatine runs backward to the pterygoid so as to completely conceal the hemipterygoid from below.

The *dentary*, *angular*, *supra-angular*, *splenial*, and *coronoid* are all still traceable, but fusion of these elements has begun.

iv. The Vertebral Column.

All the presynsacral vertebræ are free, the thoracic are heterocœlous. The cervicals somewhat recall those of the Steganopodes. The odontoid ligament of the atlas is not ossified. The neural arch is deeply notched anteriorly and posteriorly, and meta- and hyperapophyses are more or less well developed. In many the anterior cervicals have a bony bar running forward from the hyperapophysis to the base of the anterior zygapophysis. Neural spines are well developed from the 2nd to the 5th vertebræ.

The hyperapophyses of *Diomedea* are less well developed than in the Procellariidæ.

The thoracic vertebræ in the Procellariidæ bear hypapophyses; these are absent in the Diomedeidæ. The anterior hypapophyses terminate anteriorly in a flattened plate. Below the neural canal the centra of the vertebræ bear each a deep depression, which in some—e. g., *Ossifraga*, *Diomedea*—becomes a large aperture into which open numerous pneumatic foramina. Similarly, in *Ossifraga*, *Diomedea*, and the larger Petrels there are large pneumatic apertures opening above the neural canal and below the transverse processes. The vertebræ of sections A and B of the Procellariidæ are non-pneumatic.

The synsacrum includes some 13 vertebræ. Of these, the 8th or 9th represents the first true sacral and lies behind the acetabulum. Only in a few genera—e. g., *Majaqueus*, *Priofinus*, *Diomedea*—is there any distinct division into anterior and posterior renal fossæ. In many genera, e. g. *Puffinus*, all traces of the original sacral vertebræ are lost. In *Puffinus* the acetabulum lies immediately behind the parapophysis of the last lumbar vertebra; in no other genus do these relations exist, though the one is never far removed from the other.

There are 8 postsynsacral vertebræ (free caudals) including the pygostyle. The intercentra of these vertebræ have been described and figured by Beddard (2). There are 15 cervicals, of which the last 3 or 4 bear free ribs increasing in size from before backwards. The thoracic vertebræ are 7 in number: making a total of 43 in all. In *Fulmarus* and *Daption* the thoracic vertebra next in front of the pre-ilium is fused with the synsacrum.

v. The Ribs.

The cervical ribs are styloid, and in the middle region of the neck are often of considerable length, e. g. *Pelagodroma*, *Puffinus assimilis*. They become very short posteriorly, and finally—on the 3 or 4 vertebræ preceding the thoracic—free. Anteriorly they fuse, above, with a process from below the anterior zygapophysis (diapophysis), below with a ventral lamella running outwards and forwards from the centrum (parapophysis). Thus a canal is formed through which the carotid passes. More or less well-marked catapophyses occur from the 6th to 10th vertebræ. There are 7 pairs of thoracic ribs, all of which, save the last, articulate by means of sternal segments with the sternum. The sternal ribs of the 7th pair are attached by ligament to the posterior border of those next in front. In *Pelecanoides* the thoracic and sternal ribs increase greatly in length from before backwards so as to recall those of the Alcidæ. In *Pelecanoides* and *Diomedea* only are two pairs of thoracic ribs overlapped by the ilium.

Uncinates are present in all but the last one or two pairs. In *Pelecanoides* they are placed in the same horizontal plane and about halfway down the shaft. In all other cases they are seated anteriorly low down, near the distal $\frac{1}{3}$ of the rib and rise backwards to about its middle. They are moderately long and slope obliquely upwards. In all cases they project beyond the rib next behind, and often extend to that succeeding this.

A very useful table showing the number of the vertebræ, ribs, and uncinate processes in the different genera is given in Forbes's memoir (6).

vi. The Sternum and Pectoral Girdle.

The *sternum* assumes two forms—(1) that in which the posterior border is notched, and (2) that in which it is entire. The first includes all the genera except *Pelecanoides*, and the small forms included under sections A and B of the Procellariidæ—e. g., *Procellaria*, *Oceanites*. When the posterior border is notched, the anterior coracoid border is produced forwards far beyond the level of the anterior lateral processes. When the posterior border is entire, the anterior, coracoid border does not project far forwards. *Pelecanoides* belongs to this last division, but can at once be distinguished from the rest by reason of its great length in proportion to its width, in the feeble development of the *spina externa*, and in that the articular surfaces of the sternal ribs are confined to the free edge of the anterior lateral process. In *Oceanites* and *Pelagodroma* there is a large fenestra in the anterior dorsal region of the carina. As will be seen by the appended Key, the various genera which have a notched sternum can only very imperfectly be distinguished one from another.

Pneumatic foramina opening on to the dorsal aspect of the sternum occur in *Majaqueus*, *Priofinus*, *Ossifraga*, and *Diomedea*.

The *coracoid* is of great width across the base. This is especially the case in those genera which have a notched sternum; in these, the shaft is shorter not only in proportion to the width of the base, but also in proportion to the length of the sternum. The width of the base is relatively least in *Pelecanoides*, in which it does not exceed half the length of the shaft, and greatest in *Diomedea*, in which the breadth of the base and the length of the shaft are nearly equal. The procoracoid is large, and there is a supracoracoid foramen. There is no articular facet on the acrocoracoid for the furculum.

The *scapula* is subcylindrical and flattened at its free end, and about as long as the furculum measured from the hypocleideum across to the free end.

The *furculum* is U-shaped, and with, or without, a hypocleideum.

vii. The Pelvic Girdle.

The pelvic girdle of the Petrels most nearly resembles that of the Sphenisci. The resemblance in the case of the Diomedeidæ, however, is less marked, as the pelvis, like the rest of the skeleton in this Family, is more specialized.

In the Procellariidæ, save in *Ossifraga*, the innominate bone remains free throughout life, and the pre-ilia do not meet in the mid-dorsal line above the synsacrum. The pre- and post-ilia are of about equal length. The ischium is produced far backwards and beyond the post-ilium, and turns sharply downwards to join the pubis, with which its free end is firmly united by ligament. The ilio-ischiadic foramen is large; the obturator fissure is very wide and opens forward into the obturator foramen. The innominate of the Penguin differs from that of the Petrel in the smaller size of the ilio-ischiadic foramen, and the shorter and wider ischium. To the increase in the width of the latter the narrowness of the fissure is due.

In *Ossifraga* the innominate is fused with the synsacrum, and the pre-ilia rise forwards to the level of the neural crest of the synsacrum.

In *Pelecanoides* the pre-ilia are reduced to narrow bars of bone articulating with the extreme outer edge of the transverse synsacral ridge, whilst the pubis and ischium are produced directly backwards with a slight downward curve precisely similar to that of the Alcidæ, with which group they also agree in the great length of the posterior thoracic and sternal ribs, thus affording us another instance of the modification of parts by adaptation to similar functions.

In the Diomedeidæ the innominate is not only fused with the synsacrum, but the pre-ilia meet in the mid-dorsal line above its neural crest. The pelvis as a whole, on account of this, comes to resemble that of *Sula*. Other Ciconiiform resemblances have already been pointed out in describing the skull of this family. They suggest a parallel development of characters derived from a common source.

viii. The Pectoral Limb.

The character of the wing is very uniform throughout the group. It is perhaps most nearly comparable to that of the Laridæ. It may be distinguished from that of this last group by the absence of a groove for the deltoideus minor, and in that the 1st phalanx of digit II. is not fenestrated.

The *humerus* in the Procellariidæ has the shaft dorso-ventrally depressed. The free edge of the pectoral crest is triangular, the caput humeri is low and not sharply defined; the tuberculum inferius is large; the sub-trochanteric fossa is of moderate size, is single (not bipartite as in the Gulls), and does not receive pneumatic apertures. The coraco-humeral groove is very shallow. The crista inferius small. The ectepicondylar process is very long. The supracondylar depression for the brachialis inferior is moderately large and deep, but less so than in the *Lari*, in which it forms a very deep pit, saved only from fenestration by a very delicate floor of bone.

The dorso-ventral flattening of the wing is very marked in *Puffinus*, and the supratrochlear depression is shallower than in the more typical humeri, such as those of *Majaqueus* and *Priofinus*. The shaft is almost cylindrical in the smaller Petrels belonging to sections A, B of this paper. The ectepicondylar process is not well developed, and the supratrochlear depression is shallow.

The relative proportions in the length of the arm, forearm, and manus vary considerably amongst the different genera, too much so to be of use for systematic purposes. All the segments appear to be subequal in *Puffinus*, some species of *Œstrelata*, *Priocella*, and *Fulmarus*; the manus is longest of the three in *Thalassœca*, *Puffinus assimilis*, and *Œstrelata neglecta*; it is shortest in *Majaqueus* and *Daption*.

In *Pelecanoides* the pectoral crest is feebly developed, straight and scarcely raised above the level of the shaft. The *crista inferior* is deeply hollowed distad, and the ectepicondylar process and supratrochlear depression are obsolescent.

In the Diomedeidæ—e. g. *D. exulans*—the proximal end of the humerus is squarely truncate. The *tuberculum inferius* widely separated from the *caput humeri*. The *crista inferior* has its free edge swollen into a thick lip immediately before entering the shaft. The subtrochanteric fossa is very small and receives numerous pneumatic foramina. The supratrochlear depression is shallow, inverted-pyriform, and extends some distance up the shaft. The depression proximad of the ulnar condyle is relatively deeper.

The *forearm* can be distinguished from that of the *Lari* by the absence of distinct tubercles for the quills, and the presence of a more or less deep and elongated groove in the inferior aspect of the ulna lying in front of the inferior glenoid cavity.

The *manus* in all cases, save apparently sections A, B of the Procellariinæ, can be distinguished from the *Lari* by the great length of the terminal phalanges.

In *Majaqueus* and *Diomedea exulans*, for instance, the 2nd phalanx of digit II. exceeds that of the 1st. Phalanx i. of digit I. is equal in length to that of phalanx i. digit II. In *Diomedea* again it is rather less instead of equal. In the smaller Petrels the elongation of these phalanges is not so marked.

ix. The Pelvic Limb.

The bones of the pelvic limb are non-pneumatic; the tibio-tarsus is characterized by an enormous flabelliform ectocnemial crest which rises high above the articular surface for the femur: is markedly inflected at its distal end, and provided with an ossified extensor bridge. The fibula does not extend more than $\frac{2}{3}$ the way down the leg, and is much reduced in thickness distally. The tarso-metatarsus has a well-marked intercondylar tubercle. The hypo-tarsus is complex in the Procellariidæ and simple in the Diomedeidæ. The outer and middle toes are of equal length.

In one skeleton of *Diomedea exulans* I find an ossified tarso-metatarsal extensor bridge on the right foot. The hallux is represented by a metatarsal and an ungual phalanx, the latter often of considerable size. In *Pelecanoides* it is absent. The femur, as a rule, is about as long as, or less than, the tarso-metatarsus, and is about half as long as the tibio-tarsus; in *Oceanites*, *Pelagodroma*, *Cymodroma*, and *Procellaria* the femur shortens conspicuously, these measurements being about $\frac{1}{2}$ as long as the tarso-metatarsus and $\frac{1}{3}$ as long as the tibio-tarsus.

x. Results.

Briefly, I think, the outcome of this paper has been to confirm, in a large measure, the conclusions of Forbes as set forth in his most valuable Report on the Petrels collected during the 'Challenger' Expedition (5). The appended diagram (fig. 2, p. 402) is a modification of that published by him in that work. He divided this suborder into two families—Procellariidæ and Oceanitidæ; and two subfamilies—Procellariinæ and Diomedeinæ. *Pelecanoides* he regarded as an aberrant genus of the first mentioned subfamily.

I propose to make two Families—the Procellariidæ and the Diomedeidæ; the former being further divided into two subfamilies—Procellariinæ and Pelecanoidinæ. Thus Forbes's Diomedeinæ becomes raised to the rank of a family, his genus *Pelecanoides* to the rank of a subfamily, whilst his family Oceanitidæ becomes, in my scheme, reduced to a section of the Procellariinæ. The sections in this subfamily are three in number, and can quite conveniently be diagnosed from the characters of the skull alone (see Keys, pp. 403–409).

Pelecanoides forms the second subfamily. In the great width of the basitemporal region of its skull it differs from every other member of the suborder. The sternum and pectoral girdle are

also peculiar, as is the pelvis. If only on account of these differences it must, I think, be allowed to take higher rank than that accorded by Forbes, though they seem scarcely important enough to demand the formation of a separate family as has been done by Salvin (18) for instance.

Fig. 2.

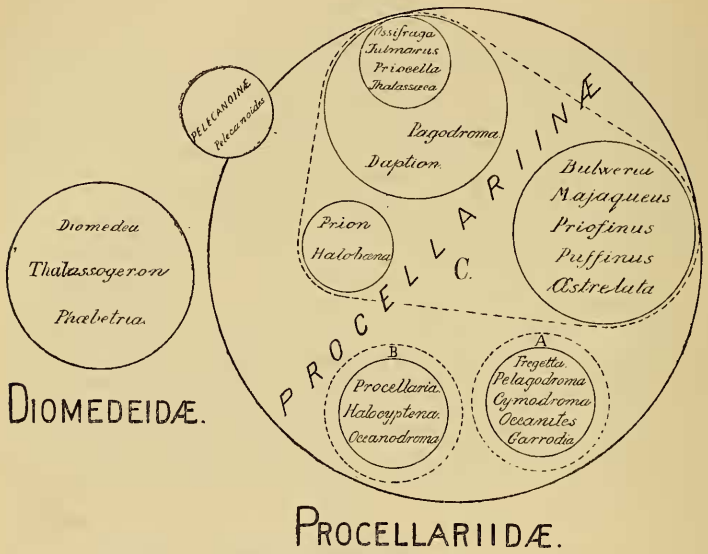


Diagram to indicate the inter-relationships of the Tubinares.

Ossifraga is undoubtedly the most highly specialized of the Procellariinæ. With this genus Forbes has placed *Fulmarus*, *Priocella* (*Thalassœca*), *Thalassœca* (*Aeipetes*), and a little further removed *Pagodroma* and *Daption*. The study of the skeleton seems to confirm the wisdom of this. I cannot, however, express an opinion as to *Pagodroma*, this genus not being represented in the Museum's collection of skeletons. Salvin has associated the genera *Priocella* and *Thalassœca* with the second of Forbes's large groups of genera, containing *Bulweria*, *Majaqueus*, *Priofinus* (*Adamastor*), *Puffinus*, and *Œstrelata*.

Halocyptena, *Pagodroma*, *Halobœna*, and *Garrodia* are as yet unrepresented among the skeletons under my charge.

Prion has a skeleton closely resembling that of *Daption* and the forms associated therewith, in this and Forbes's papers. It differs from these mainly in the great breadth of the boat-shaped upper jaw and in the short wide palatines; in its pelvis it most nearly resembles *Bulweria* and *Œstrelata*.

Coming to the DIOMEDEIDÆ, I regret that of the genera *Thalassogeron* and *Phœbetria* I have only seen skulls, but the differences

between these and that of *Diomedea* seem sufficiently marked to entitle them to the rank of genera. The collection contains complete skeletons of two species of *Diomedea*.

The hemipterygoid of the Petrel is here described and figured (Pl. XXIII. figs. 3, 4) for the first time.

The indications of the Ciconiiform affinities of the Petrels pointed out by other writers have been verified and additional points brought to light. It would seem that the Petrels must be regarded as a very ancient group, undoubtedly by no means remotely allied to the Sphenisci, Colymbi, and the Ciconiiformes. Their Ciconiiform affinities are most clearly seen perhaps through the palate. That of *Diomedea*, for instance, presents many points in common both with *Fregata* and with *Ciconia* that can hardly be attributed to any other source than that of derivation from a common ancestor. The holorhinal nares, the temporal fossæ, and deep supra-orbital grooves they share in common with the Penguins and the Divers. The pelvis of the Procellariidæ seems to be traceable to a form most closely resembling that of the Penguins. That of the Diomedeidæ is more specialized, and in the adult, at least, resembles not a little that of the Ciconiiform type. Besides the Petrels, the Grebes and Divers are the only other birds which have the cnemial crest greatly developed so as to rise high above the articular surface of the femur. This can hardly be regarded as an adaptation in the case of the Petrels, for they are not great swimmers, and do not therefore use their legs as do the Divers.

As to the arrangement of the group in the present paper, I can only regret my inability to adopt *in toto* that of any of those to whose works we are so greatly indebted; it is to be hoped that in the near future some sort of harmony will come of the existing somewhat unsatisfactory state of affairs. The present scheme—as adopted in this paper—though based largely on the osteology, is not entirely founded thereon; but has been framed with a due regard to the claims of other anatomical facts.

xi. Key to the Osteology of the Tubinares.

A. Skull. (Plates XXII., XXIII.)

The skull is holorhinal and schizognathous; with more or less deep supra-orbital grooves; a large, laterally expanded vomer fused posteriorly with the palatines; an olfactory cavity of great size; a large antorbital plate; and a hooked upper jaw.

A. Supra-orbital grooves without an external overhanging ledge; temporal fossæ, when present, in the form of deep depressions approaching one another in the middle line, and tending to cut off the cerebral from the cerebellar portions of the skull; external nares large, divided into right and left apertures by a narrow bar of bone in the mid-dorsal line; length of the upper jaw never greatly exceeding that of the cranium; orbito-sphenoid imperfectly ossified; basipterygoid processes well developed or in the form of minute prickles; with a conspicuous tubular parasphenoidal pneumatic aperture opening downwards above the Eustachian grooves; palatines long, sharply defined anteriorly at their junction with the maxillo-palatine processes, which are small and plate-like lamellæ never projecting

downwards beyond the level of the tomium, nor extending backwards into the lachrymo-nasal fossæ; interorbital septum perforate.
PROCELLARIIDÆ.

a. Width of the basitemporal plate slightly or not at all exceeding the length of the pterygoid..... *Procellariinæ*.

b. Width of the basitemporal plate much exceeding the length of the pterygoid—very slightly less than the distance between the quadrates.
Pelecanoidinæ.
(One genus only, *Pelecanoides*.)

B. Supra-orbital groove with a more or less extensive overhanging ledge, the free edge of which is flattened; temporal fossæ represented by shallow semicircular depressions of uniform depth, separated each from its fellow by the broad, quadrangular, shield-shaped roof of the skull; external nares small, opening laterally underneath a broad culmen; orbitosphenoid completely ossified; length of the upper jaw greatly exceeding that of the cranium; basipterygoid processes absent, with the parasphenoidal pneumatic aperture opening above the Eustachian groove in a narrow chink; palatines closely approximated in the middle line so as nearly to conceal the vomer; palatines relatively short, becoming fused distally with the maxillo-palatine processes, which project downwards far below the level of the tomium; maxillo-palatine processes large, more or less fenestrated, extending vertically upwards and backwards into the lachrymo-nasal fossa..... DIOMEDEIDÆ.

Key to the Genera of Procellariinæ.

GROUP A. Supra-orbital grooves, shallow but very wide, semilunar in shape, almost or quite meeting in the middle line; lachrymal free, with a wide chink between its dorsal border and the frontal; temporal fossæ feebly developed or absent.

a. Without spine-like wings behind the supra-orbital grooves.

a'. Basipterygoid processes absent; maxillo-palatines approaching the mid-ventral line, distinct from the palatines; supra-orbital grooves separated by a thin linear ridge ..... *Oceanites*.

b. With a conspicuous pair of "wings" behind the supra-orbital grooves.

b'. Basipterygoid processes vestigial—in the form of prickles; maxillo-palatines approaching in the middle line, and partially fused with the palatines.

a''. Supra-orbital grooves separated by a shallow median groove.
Cymodroma.

b''. Supra-orbital grooves separated by a median linear ridge.
Fregetta.

c'. Basipterygoid processes absent; maxillo-palatines approximating to the middle line, and quite distinguishable from the anterior ends of the palatine; supra-orbital grooves separated by a thin linear ridge..... *Pelagodroma*.

GROUP B. Supra-orbital grooves very narrow, excavated out of the free edge of the frontal and separated by a very broad interorbital median ridge.

a. Basipterygoid processes represented by minute prickles; lachrymal free, its dorsal border closely applied to the frontal; maxillo-palatine processes concealed from below by the palatines ..... *Procellaria*.
Halocyptena [1].
Oceanodroma.

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[1] Adult skulls of *Halocyptena* and *Oceanodroma* not represented in the Museum collections.

Group C. Supra-orbital grooves deep and wide, sharply defined, and tending to meet in the middle line; pterygoids rod-shaped, with articular surfaces for the basipterygoid processes—which are often vestigial; vomer more or less boat-shaped, not cleft more than half its length; length of anterior nares never more than ½ that of upper jaw.

a. Lachrymal free.

a'. Supero-external angle of antorbital plate incomplete, forming with the lachrymal a large foramen ..... *Puffinus.*
Priofinus.
Majaqueus.

b'. Supero-external angle of antorbital plate complete, closing the space between itself and the lachrymal ..... *Bulweria.*

b. Lachrymal anchylosed with nasal.

c'. Size very large; basioccipital with well-developed mammillary processes; a large space between the dorsal border of the antorbital plate and the frontal; postorbital processes turning downwards and ending in a point; lachrymal with the horizontal greatly exceeding the vertical axis; quadrato-jugal bar with a strongly marked triangular process for articulation with the quadrate..... *Ossifraga.*

d'. Size not exceeding 4 inches; basioccipital without mammillary processes; postorbital processes with a squarely truncate outer border; lachrymal with the horizontal and vertical axes about equal; quadrato-jugal bar of uniform thickness throughout.

a''. Interorbital region of frontals dividing supra-orbital grooves moderately wide; lachrymal with its postero-dorsal free edge produced laterally into a pair of conspicuous wings.

a^3. Vomer tapering anteriorly to a point; beak stout and wide, not conspicuously narrower at the tip; anterior palatine vacuity very wide, not bounded by a flattened ledge on either side; palatines elongated, ventral surface conspicuously keeled posteriorly.

a^1. Temporal fossa deep, nearly meeting in mid-dorsal line. *Fulmarus.*

b^1. Temporal fossa shallow, divided by the roof of a distinct cerebellar prominence .... *Daption.*

b^3. Anterior end of vomer more or less hidden by the maxillo-palatine processes, which meet in the middle line; palatines short and broad, proximal end *not* conspicuously keeled; anterior palatine vacuity narrow, bounded on either side by a flattened ledge; beak more or less conspicuously depressed, the extreme form resembling that of *Balæniceps*..... *Prion.*

c^3. Vomer terminating anteriorly in a long spine; palatines elongated; beak slender.

c^1. Anterior limb of free bifid end of lachrymal longest; interorbital region of frontals less than width of supra-orbital groove. *Thalassœca.*

d^4. Posterior limb of bifid end of lachrymal longest and directed backwards; interorbital region of frontals much greater than width of supra-orbital grooves ..... *Œstrelata.*

b''. Supra-orbital grooves divided by a thin bony ridge ... *Prioœella.*

Diomedeidæ.

a. Interorbital region of frontals broad; antorbital plate not extending outwards to the level of the outer margin of the lachrymal; with a well-marked tubercle lying between the mammilary processes.

a'. Interorbital region of frontals not exceeding ⅓ of the width of the frontals between the lachrymals; pterygoid ends of the frontals becoming abruptly wider in the region of a line drawn through the median palatine keel ..... *Diomedea.*

b'. Width of interorbital region of the frontals exceeding ½ that of the frontals between the lachrymals; pterygoid ends of the palatines gently widening from behind forwards ..... *Thalassogeron.*

b. Interorbital region of frontals reduced to a narrow median ridge; antorbital plate extending outwards to the level of or beyond the outer border of the lachrymal; no tubercle between the mammillary processes. *Phœbetria.*

B. Vertebræ.

All the presynsacral vertebræ are free and heterocœlous; the centra of the thoracic bear more or less conspicuous lateral depressions and are often highly pneumatic; only the 2nd–5th or 6th cervicals bear neural spines; all the cervicals from the 2nd bear ribs in the form of elongated and very slender styles, they become free and bear a distinct capitulum and tuberculum on the last 3 vertebræ (cervico-dorsals); the free caudal vertebræ bear distinct intercentra, and in the larger species the neural arch of each is provided with a pair of processes directed forwards and embracing the neural spine of the vertebra next in front; catapophyses of cervicals never meeting in mid-ventral line to form a canal.

A. Many if not all the thoracic vertebræ bear elongated hypapophyses, of which the cephalad are bifid..... *Procellariidæ.*

B. Thoracic vertebræ without hypapophyses..... *Diomedeidæ.*

C. Sternum and Pectoral Girdle.

The posterior border of the sternum may be either notched or entire. In the former the anterior coracoid border is produced forwards beyond the level of the anterior lateral process. In the latter the anterior coracoid border does not project far forwards. The base of the coracoid is always of great width, and the furculum articulates by ligament with the antero-ventral angle of the carina.

A. Pneumatic foramina of the dorsal surface of the sternum, when present, never very conspicuous, and confined to the anterior region of the middle line; carina sharply defined throughout the whole length of the sternal plate; spina interna absent ..... *Procellariidæ.*

a. Coracoid grooves forming markedly oblique angles with the long axis of the sternum; base of coracoid more than ½ as broad as long; articular surfaces of sternal ribs extending backwards far beyond the anterior lateral processes.

a'. Posterior border of the sternum entire; clavicle with a hypocleideum; spina externa pointed.

a''. Hypocleideum small; width of posterior border of sternum much less than its long axis ..... *Procellaria.*

b''. Hypocleideum long.

a^3. Width of posterior border of sternum = length of long axis of sternal plate; carina unfenestrated ..... *Cymodroma.*

b^3. Carina fenestrated; posterior border of sternum wider than length of long axis..... *Fregetta.*

c^3. Carina fenestrated; with posterior border of sternum less than long axis; anterior lateral process only slightly projecting above the base of the coracoid; width of base of coracoid falling far short of length of its long axis ..... *Oceanites.*

d^3. Metasternum projecting beyond the posterior lateral processes; carina fenestrated; anterior lateral processes projecting considerably over the base of the coracoid; width of coracoid at base nearly equal to the length of the shaft; width across posterior border of sternum less than its long axis ..... *Pelagodroma.*

b'. Posterior border of sternum with four deep notches; spina externa blunt or bifid ..... *Puffinus.*
Majaqueus.
Bulweria.
Prion.
Œstrelata.
Pagodroma.

c'. Outer pair of notches obliterated or feebly developed (sometimes forming fenestræ) ..... *Priocella.*
Thalassœca.
Fulmarus.
Priofinus.

d'. Posterior border of sternum with 4 very slight notches; corpus sterni with pneumatic opening on anterior region of dorsal surface. *Ossifraga.*

b. Coracoid grooves forming a right angle with the sternum; base of coracoids not more than $\frac{1}{3}$ the width of the long axis; sternal ribs almost entirely confined to anterior lateral process; furculum without a distinct hypocleideum; posterior border of corpus sterni entire... *Pelecanoides.*

B. Pneumatic foramina of dorsal surface of sternum conspicuous, extending along the whole length of median line of the sternum; carina merging into the sternal plate some distance in front of the metasternum; posterior lateral processes projecting far beyond the level of the metasternum. *Diomedeidæ.*

D. Pelvic Girdle.

Pre- longer than post-acetabular ilium; ischium produced far backwards in the form of a long narrow bar of bone, its free end deflected and firmly bound to, or even fused with, the pubis, so that the obturator fissure is closed behind; obturator foramen never completely shut off from the fissure.

A. Pre-ilia not meeting in the mid-dorsal line above the neural crest of the synsacrum; innominate free.

a. Size small, total length of pelvis not exceeding 1·4 in.; postacetabular ilium with its dorsal border obliquely truncated and ill-defined; free ends of ischium and pubis fused.

a'. Obturator fissure very narrow; pre-ilia widely separated; obturator foramen open posteriorly; lumbar enlargement of synsacrum large and lying in front of the acetabular region.

a''. Pre-ilium not expanded distally ..... *Procellaria.*
b''. Pre-ilium expanded distally ..... *Oceanodroma.*

b'. Obturator fissure very wide; lumbar enlargement of synsacrum slight, lying in mid-acetabular region.

c''. Pre-ilia not rising beyond the level of the base of the synsacral neural crest; obturator foramen separated from the fissure by a broad bar of bone ..... *Pelagodroma.*

d''. Pre-ilia rising to the level of the top of the neural crest, or nearly so.

a^3. Obturator foramen and fissure confluent.

a^4. Dorsal border of pre-ilium pressed closely to the lumbar enlargement, which is almost entirely preacetabular; greatest width of synsacrum about $\frac{1}{3}$ its length ..... *Oceanites.*

b^4. Dorsal border of pre-ilium separated by a deep groove from the lumbar enlargement; greatest width of synsacrum about $\frac{1}{2}$ its length ..... *Cymodroma.*

b^3. Obturator foramen separated from the fissure by a broad bar of bone; pre-ilia pointed in front .. .. *Fregetta.*

b. Size larger, not less than 2½ in. (*Bulweria* alone excepted); postacetabular ilium with dorsal border well-defined and terminating in a well-marked spine.

c'. Pre-ilium moderately broad and expanded distally, resting upon the synsacrum and partly concealing it; ischium having its free end more or less sharply deflected.

e''. Post-ilium with flattened dorsal aspect, rapidly tapering to form a laterally-compressed blade-like edge, terminating in a spine; obturator foramen an elongated oval twice length of the acetabulum; free end of ischium bent at right angles to long axis, narrow and tapering to a point ..... *Puffinus.*
Majaqueus.

f''. Post-ilium slightly or not at all compressed dorsally; pubis projecting distinctly beyond the ischium; ischium with broad flattened foot closely articulating with pubis.

c^3. Ischiadic foramen nearly circular; dorsal border of pre-ilium concave.

c^4. Width of dorsal aspect of post-ilium rapidly decreasing from before backwards; post-iliac spine ill-defined ... *Thalassœca.*
d^4. Width of dorsal aspect of post-ilium broad throughout; post-iliac spine well-defined..... *Priocella.*

d^3. Ischiadic foramen oval; dorsal border of pre-ilium straight.

e^4. Thoracic vertebra immediately in front of pre-ilium fused with synsacrum.

a^5. Entire length of pelvis not less than 3¼ in. ..... *Fulmarus.*
b^5. Entire length of pelvis not exceeding 2½ in. ..... *Daption.*

e^3. Lumbar enlargement forming a distinct tumid swelling in front of acetabulum.

f^4. Ischium never completely fused with pubis posteriorly.

c^5. Anterior border of pre-ilium obliquely truncated; ischium tapering to a fine point ..... *Œstrelata.*
d^5. Anterior border of pre-ilium squarely truncated; ischium of equal width throughout ..... *Bulweria.*

g^4. Pubis completely fused posteriorly with ischium ... *Prion.*

d'. Pre-ilium reduced to narrow bars, separated one from another by the whole width of the synsacrum; ischium in the form of a long slender spine running directly backwards ..... *Pelecanoides.*

B. Pre-ilia meeting in the mid-dorsal line above the synsacral neural crest; suture dividing innominate bones from synsacrum almost or quite obliterated.

a. With a more or less well-marked pectineal process; free end of ischium turning downwards in a strong curve; pubis of uniform thickness throughout; cavity of pelvis not divided into anterior and posterior renal fossæ ..... *Ossifraga.*

b. No pectineal process; free end of ischium not abruptly curved; cavity of pelvis distinctly divisible into anterior and posterior renal fossæ; ribs of sacral vertebræ extending across renal cavity immediately behind acetabulum ..... *Diomedea.*

E. Pectoral Limb.

Humerus with a shallow coraco-humeral groove; a triangular pectoral crest not extending far down the shaft; crista inferior very small, formed for the most part by the downwardly-directed tuberculum inferius; with a large ecto-epicondylar process, and a more or less deep fossa for the brachialis internus; the sub-trochanteric fossa is in no case of more than medium size, and never subdivided into two; the ulna is without an olecranon process; the phalanx of the pollex and the 2nd phalanx of Mc. II. are of great length.

A. Humerus non-pneumatic; crista inferior never inflated along its free edge. *Procellariidæ.*

B. Humerus pneumatic; crista inferior inflated along its preaxial border; sub-trochanteric fossa small, receiving several pneumatic foramina. *Diomedeidæ.*

F. Pelvic Limb.

All the bones non-pneumatic; tibio-tarsus with a greatly enlarged ecto-cnemial crest forming a large flabelliform crest rising high above the articular surface; with an extensor bridge; outer and middle toes of equal length; hallux more or less vestigial; tibio-tarsus with a more or less well-marked intercotylar tubercle; 1st phalanx of D. II. = to or longer than that of D. III.

A. Hypotarsus complex ..... *Procellariidæ.*

a. Tarso-metatarsus longer than the outer toe.

a'. Ungual phalanges flattened; basal phalanx of middle toe as long as or longer than next two taken together (*Forbes*).

a''. Tarso-metatarsus markedly longer than the outer toe, grooved anteriorly throughout, its length = $\frac{1}{2}$ that of the tibio-tarsus; ph. 1 of D. II. longer than ph. 1, D. III. & IV. ..... *Cymodroma.*

b''. Tarso-metatarsus much longer than outer toe; trochlea all in same plane; grooved anteriorly, much flattened distally antero-posteriorly; 3 toes nearly = ph. 1, D. II. & III., = longer than IV. *Fregetta.*

c''. Tarso-metatarsus longer than outer toe, $\frac{2}{3}$ as long as tibio-tarsus; fibular ridge scarcely longer than the width across the proximal articular surface of the tibio-tarsus; basal phalanges of D. II. and III. = and longer than that of IV. ..... *Oceanites.*

d''. Tarso-metatarsus much longer than the outer toe, $\frac{2}{3}$ as long as tibio-tarsus, with a shallow groove throughout its whole length; basal phalanges D. II. and III. = and longer than IV.; outer and middle toes equal..... *Pelagodroma.*

b'. Ungual phalanges pointed; basal phalanx of middle toe shorter than next two joints (*Forbes*).

e''. Tarso-metatarsus only slightly longer than the outer toe; fibular ridge obsolete..... *Procellaria.*

b. Tarso-metatarsus shorter than outer toe, but much longer than femur.

c'. Fibular ridge obsolescent.

f''. Tarso-metatarsus faintly grooved anteriorly, its outer border raised into a sharp ridge ..... *Puffinus.*

g''. Tarso-metatarsus deeply grooved anteriorly, outer border not conspicuously developed ..... *Bulweria.*

d'. Fibular ridge distinct.

h''. Tarso-metatarsal groove nearly obsolete ..... { *Daption.* *Prion.*

i''. Tarso-metatarsus grooved anteriorly and posteriorly ... *Œstrelata.*

j''. " " "

a^3. Groove deeper, length not exceeding $2\frac{1}{2}$ in. ..... *Majaqueus.*

b^3. Groove shallower, length not less than $3\frac{3}{4}$ in. ..... *Ossifraga.*

c. Tarso-metatarsus shorter than outer toe, scarcely longer than femur.

k''. Tarso-metatarsal groove obsolescent, hallux present.

c^3. Ectocnemial crest stronger; shaft of tibio-tarsus not exceeding $3\frac{1}{2}$ in. ..... *Thalassæca.*

d^3. Ectocnemial crest weaker; shaft of tibio-tarsus not exceeding $3\frac{3}{4}$ in..... *Priocella.*

l''. Tarso-metatarsal groove obsolescent; hallux absent ... *Pelecanoides.*

B. Hypotarsus simple; ectocnemial large, forming an acute angle with the entocnemial crest proximally; fibular ridge scarcely raised above half of shaft ..... *Diomedeidæ.*

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EXPLANATION OF THE PLATES.

Plate XXII

c.p.=cerebellar prominence.
c.r.=coronal ridge.
l.=lachrymal.
n.=nasal.
n.pmx.=nasal process of premaxilla.
q.=quadrate.
s.c.=sagittal crest.
sq.p.w.=squamoso-parietal wing.
s.o.g.=supraorbital ridge.
s.o.l.= ,, ledge.
t.f.=temporal fossa.

The Dorsal Aspect of the Skull.

Fig. 1. The skull of *Puffinus kuhli*, nat. size, to show the large temporal

fossæ, the backward position of the squamoso-parietal wings, the sagittal crest, coronal ridge, and large supraorbital grooves and lachrymals.

Fig. 2. The skull of *Prion vittatus*, nat. size (p. 389), to show the great development of the upper jaw, the form of the supraorbital grooves, the cerebellar prominence, temporal fossæ, and fused lachrymals.

Fig. 3. Skull of *Procellaria pelagica*, nat. size (p. 404), to show the feebly-developed supraorbital grooves and the great width of the interorbital region of the frontals.

Fig. 4. The skull of *Cymodroma melanogaster*, nat. size (p. 404), to show the form of the supraorbital grooves, the spine-like wings of the free end of the squamosal, and the lachrymals, which are partly separated from the frontals by a space.

Fig. 5. The skull of an Albatross, *Diomedea exulans*, $\frac{2}{3}$ nat. size (p. 404), to show the great size of the supraorbital groove and ledge, and the shallow femoral fossæ, confined to the lateral surface of the cranium.

Fig. 6. The skull of *Oceanites oceanicus*, nat. size (p. 404), to show the form of the supraorbital grooves.

Plate XXIII.

Additional Letters.

als.=alisphenoid.
a.o.p.=antorbital process.
ant.=antrum of Highmore.
an.h.= „ „ „
b.p.=basipterygoid process.
bt.p.=basitemporal platform.
b.s.=basisphenoid.
e.b.v.=cerebral vein.
eu.g. + *pn.ap.*=Eustachian groove + pneumatic aperture.
ep.o.=epiotic.
ex.=exoccipital.
f.f.=floccular fossa.
fr.=frontal.
h.pt.=hemipterygoid.
m.=meatus internus.
mes.=mesethmoid.
op.=opisthotic.
p.=parietal.
pa.=palatine.
par., pr.=parasphenoid.
pn.ap.=pneumatic aperture.
pro.=proötic.
pt.=pterygoid.
s.o.=supraoccipital.
s.s.=squamosal spine.
sq.=squamosal.
t.r.=temporalis recess.
v=vomer.
v.f.=vagus foramen.

Fig. 1. Lateral aspect of skull of nestling *Oceanodroma leucorrhoa*, outer view, ×2 (p. 393), to show the unclosed sutures.

Fig. 2. Lateral inner view, longitudinal section, of same skull (fig. 1), ×2, to show unclosed sutures.

Fig. 3. Dorsal aspect of palatines, pterygoid, and vomer, ×2 (p. 396), to show the form and relations of the hemipterygoid.

Fig. 4. Lateral aspect of a portion of fig. 3, ×3, outer view, to show relations of hemipterygoid.

Fig. 5. Ventral aspect of *Pelecanoides garnoti*, nat. size (p. 383), to show the form and great size of the basitemporal platform.

Fig. 6. Dorsal aspect of the vomer and neighbouring parts of the skull of *Diomedea exulans*, $\frac{2}{3}$ nat. size (p. 390).

Fig. 7. Lateral aspect of same dissection as fig. 6, to show form of vomer, $\frac{1}{2}$ nat. size (p. 391). Note in figs. 6, 7, and 8 the antrum of Highmore.

Fig. 8. Ventral aspect of skull of *Diomedea exulans*, to show the schizognathous palate, $\frac{2}{3}$ nat. size (p. 390).